Jason Farrow
Senior Vice President
Public Affairs

SONY

Sony Electronics Inc.
1 Sony Drive
Park Ridge, New Jersey 07656-8003
Telephone (201) 930-6440
Fax (201) 358-4058

August 12, 1996

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

William F. Caton
Acting Secretary
Federal Communications Commission
Room 222
1919 M Street, NW
Washington, DC 20554

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Dear Mr. Caton:

I am enclosing an original and nine copies of reply comments by Sony Electronics Inc. in response to the Commission's Fifth Further Notice of Proposed Rulemaking in MM Docket No. 87-268, Advanced Television Systems and Their Impact Upon the Existing Television Broadcasting Service.

We would appreciate your forwarding copies to the offices of all the Commissioners.

Very truly yours,

Jason Farrow jmb

Jason Farrow

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In the Matter of	)	
	)	
Advanced Television Systems	)	
and Their Impact Upon the	)	MM Docket No. 87-268
Existing Television Broadcast	)	
Service	)	

FIFTH FURTHER NOTICE OF PROPOSED RULE MAKING

REPLY COMMENTS OF SONY ELECTRONICS INC.

Jason Farrow
Senior Vice President, Public Affairs
Sony Electronics Inc.
One Sony Drive
Park Ridge, NJ 07656

COMMENTS OF SONY ELECTRONICS INC.

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I. INTRODUCTION

Sony Electronics Inc. (SEL) is the research, design, manufacturing and distribution subsidiary of Sony Corporation of America. SEL participated in the process which resulted in the recommendation of the ATSC DTV standard and filed comments in support on July 12, 1996. As did most commenters, we supported the ATSC DTV standard and urged the Commission to mandate it in its entirety. We explained the technical and practical bases for inclusion in the standard of some interlace formats, the 60Hz transmission rate, 16:9 aspect ratio, the recommended colorimetry standard and the necessity for non-square pixels for a smooth transition.

We emphasized that only by mandating a standard will the Commission afford the certainty required to all the many stakeholders whose enthusiastic participation is necessary for a successful implementation of DTV in the United States.

Because of the tremendous number of comments filed, it is not possible to address in this reply even all of the issues deemed important. Therefore, we have necessarily focused on those points to which we could add the most insight based on our history as a major manufacturer of professional broadcast equipment and consumer television receivers, our record of close cooperation with many major members of the computer and telecommunications industries and our business strategy of even more direct participation across all these industries in the future. Our reply focuses on the following:

- Our flat rejection of the CICATS proposal for a "base-line" format that seeks to limit the inauguration of a U.S. DTV service to SDTV.

- Our exposure of the flawed assumptions underlying the CICATS cost model for the DTV converter.
- Our return to the inevitable interlace-progressive debate which continues to serve as the technical centerpiece of opposition to the ATSC DTV standard.

At the outset SEL believes it critical to return to the basic purpose of this nine year old proceeding -- to establish a new standard for the transmission of over the air advanced television systems. The great accomplishment of the Grand Alliance system is that is has achieved this goal through the use of technology fully compatible with the needs of the computer industry. Indeed, several aspects of the system are not required for television broadcasting at all, but have been incorporated solely to meet the requirements of the computer industry (e.g., square pixels and progressive scan). This is, after all, a television standard. It must satisfy the television industry but should and does include technology friendly to computers to allow for interoperability with computer applications. But the tail cannot wag the dog. Indeed, the standard which resulted from the deliberations of the Advisory Committee (which included representatives of the telecommunications, computer, movie, cable and other industries, as well as broadcasters and manufacturers) was a compromise which tried to accommodate the interests of all. This inter-industry project was uniquely America. Therefore, it is disappointing to read the comments of some of the ATSC DTV opponents with their highly partisan, doomsday scenarios predicted if the ATSC DTV standard is adopted.

We are confident that the Commission will not be distracted by these tactics from the task at hand -- to determine the best transmission standard for an advanced television service which will preserve free-over-the-air broadcast television for American consumers.

II. THE SUBSTITUTE STANDARD PROPOSED BY CICATS IS FATALLY FLAWED.

In response to legitimate charges that the computer industry has heretofore attacked the proposed standard without suggesting a replacement, CICATS has suggested its own substitute format at this eleventh hour. It is a truly remarkable proposal. CICATS would have the Commission jettison altogether the original agenda of HDTV, settle instead for a singular base-line standard definition television format, and allow HDTV to be phased in on top of the base-line SDTV via a totally new and entirely untested systems approach. In short, they propose that the U.S. walk away from the spectacular developments of some eight years and relegate global leadership in digital broadcasting to some other region of the world! This proposal asks the American public to accept a VGA resolution picture as the embodiment of digital advanced television at the dawn of the twenty-first century in the world's most advanced information society while the computer industry at the same time widely offers SVGA computer screens. If there is logic here, it escapes SEL's television and computer experts.

Throughout, CICATS repeatedly advocates this base-line format as being the one element that ensures the future success of DTV services. Ironically CICATS represents an industry that displays no allegiance whatever to such a concept within its own multifaceted computer display environment. Considering the variety of horizontal and vertical pixel configurations possible, there are literally dozens of possible computer monitor formats and industry uses of scanning formats. The computer industry uses scanning formats with total abandon. This is inherent in a relentless, competitive dynamic that pursues incremental technical advantages tailored to a multiplicity of marketplace niches. No doubt this is a successful marketplace strategy and suggests a healthy diversity but it casts enormous doubt on the glib conjecturing common to many of the comments filed, e.g., "...the obvious solution is to develop a modular, layered framework for an open systems approach to digital television, and let the marketplace drive the evolution of the service by constantly improving functionality within the modular components of the architecture..."[1] This is not, and never has been, the model for the computer industry and certainly will not work in a television service which depends upon the certainty of compatible transmission and reception. Below, we reproduce just a small sampling of scanning formats and refresh rates for computer monitors presently in the marketplace:

Raster Structure										
# Horiz Pixels	624	640	656	738	768	800	992	1024	1280	1152
# Vert Pixels	460	480	496	414	576	600	744	768	1024	870
Vert Refresh Rate	59.94	60	59.94	70.087	75	74.653	75.029	86.85	75.021	75.06
	66.578							84.997	85.024	75.025

[1] Comments of PCUBE LABS, p.2.

The CICATS proposal for the temporal base layer is also clearly exposed as unworkable when one examines the many computer display refresh rates actually in the marketplace today. The selection of 72Hz defies all logic. The computer industry employs whatever refresh rate it deems appropriate for the specific application. Which is as it should be. It also makes all sorts of variations of any given refresh rate. This is spawned by the unfettered competitive edge sought by computer companies as they manipulate all scanning parameters to structure a new and hopefully more competitive computer monitor. But computer monitors and television receivers, although somewhat similar, are designed for different uses.

The television industry has always required a high degree of standardization. While the computer industry might not appreciate the peculiar nature of the parameter numbers underlying standards such as the ITU R 601 digital studio origination standard, they do reflect years of diligent international effort to unify the emerging digital broadcast and program production industries within a framework of two fundamentally different global scanning structures of 625/50 and 525/60.

The ATSC DTV standard went one step further beyond the 601 work. It zeroed in on a minimum set of scanning formats that will support a variety of very promising DTV services including those base-line formats deemed acceptable to computer experts who contributed to the proposed standard and agreed to the consensus.

Using history as our guide, we doubt even the computer industry itself would remain loyal to the base-line numbers suggested as part of their hastily concocted standard. Certainly such a feature would not serve the television industry well and should be rejected along with the entire CICATS proposal.

III. THE COST ISSUES RAISED BY SOME ATSC DTV OPPONENTS SHOULD BE DISREGARDED AS THEY ARE SPECULATIVE AND BASED ON UNSUPPORTED ASSUMPTIONS.

SEL seriously questions the claims contained in the CICATS response. One of the most incredible is their assertion that the proposed standard unnecessarily increases the costs to broadcasters and consumers by forcing upon them the more expensive HDTV rather than SDTV. CICATS claims the aggregate cost as an astronomical $91 billion compared to the more modest cost ($44 billion) claimed for their proposal. These claims are utterly without credible foundation. Both the specific manufacturing cost comparisons and the expanded economic analysis were prepared and presented by persons completely unfamiliar with the consumer electronics or broadcasting industries. They have selected irrelevant subjects for comparison.

In the first instance, a product very different from a television receiver is analyzed by an individual with no recognizable background in television receiver manufacturing. The cost comparison[2] was produced by Mr. S. Gabriel, described as an architect in the graphics and video systems division of the computer software giant, Microsoft. Mr. Gabriel opens with the revealing statement "...while the precise engineering and design specifications for DTV converters has not been established..."

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[2] "Cost Comparison of ACATS and CICATS Set-top Converters, Receivers and PC Decoders." Exhibit C. CICATS response.

This admission is quite significant and indicative of the lack of rigor of the cost analysis conducted and the credibility it should receive. It is simply impossible to make any realistic cost estimate without the establishment of these specifications.

The subsequent basis of his work is then made on the DSS model. This is not the model for DTV. DSS was launched with one exclusive decoder manufacturer operating within a closed circuit environment for the first year followed by approximately another year with one other manufacturer. This is quite different from the proposed DTV broadcasting environment. Many more manufacturers will participate from the outset bringing entirely different competitive dynamics and economies of scale to bear on DTV receivers and set-top boxes. Yet even Mr. Gabriel's example contradicts his point. In the six months since DSS consumer decoders have been manufactured by more than the original two, the costs have plummeted from approximately $700 to about $300 neatly demonstrating what we know will happen in the digital television receiver manufacturing process.[3]

The comparison to DSS has even more flaws. The receiver model Mr. Gabriel uses to compare to the ATSC DTV and CICATS proposed converters is comprised of three components: packaging and power supply hardware, demodulator and control circuits, and MPEG-2 decoder. Simply analyzing the manufacturing cycles of these three sections shows the inherent flaws and misconceptions which led to the false conclusions relied on by CICATS. For instance, in the packaging and power supply case, CICATS states "...in our model we assume that the cost of this section remains

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[3] Contrary to Gabriel's contention, there is no subsidy by the satellite provider to the manufacturer for the hardware production cost.

essentially constant over time...as demand (output) grows, small decreases in these costs can be expected..." This is absolutely wrong. These sections actually constitute a substantial portion of receiver costs which dramatically yield to manufacturing economies of scale. Decades of cutthroat competition have honed manufacturing ingenuities in this area. They have long been a target of cost-cutting as vendors are pressured to significantly economize by the competitive marketplace.

It is true that the demodulator/control/MPEG-2 sections will be implemented in VLSI. However, the proper comparison is not simply Moore's law of cost reduction for semiconductors. There is another crucial manufacturing dynamic at work here that is unique to the contemporary world of digital-based consumer electronics products.

The level of global competitive activities (especially in television receivers, camcorders, etc.) is such that the VLSI design cycles are virtually unceasing. This industry turns over new generations of such VLSI on a 9-12 month cycle. The relentless and grinding nature of the competition in this area of entertainment related electronics has no counterpart in the world of manufacturing. Even on a relatively exclusive product the VLSI cost reduction model is far from that postulated by Mr. Gabriel.[4] Moore's Law applies quite well to traditional computer chip microelectronics. But modern consumer electronics is an entirely different matter. CICATS clearly have no appreciation of this and consequently the cost analysis upon which so much of their base-line scenario is premised is seriously flawed and cannot be

[4] See our discussion below on the Japanese HiVision television.

credited. The entire analysis completely ignores (indeed is ignorant of) the cutthroat competition inherent in the world of consumer electronics.

We totally dismiss the CICATS mathematical model as it is in no way reflective of the true dynamics of multiple consumer electronic manufacturers fiercely competing with each other. Not only is their model without credibility, but the assumptions upon which it is based need fundamental corrections as well.

The following indicates the view of SEL consumer electronic manufacturing experts on the error of CICATS assumptions:

	CICATS	SEL
Hardware	15%	40%
VLSI (Moore's Law)	85%	60%
MPEG Decoder VLSI only (including DRAM)	50%	30%
MPEG Decoder Total Block (including DRAM)		60%
Total MPEG/DRAM Block		40%

On this basis the PDSS model is changed to:

$$PDSS(t) = PDSS[\,0.4 + 0.6 \times 2\ Exp\ (T - 1996/2)]$$

and the PACATS model becomes:

$$PACATS(t) = PDSS[0.4+0.6\{(1-0.3)+0.18+0.12 \times 5) \times 2\ Exp\ (T - 1996)/2\}$$

This in turn produces the following pricing scenario over just the first few years:

	PDSS	PACATS
Year 1	1.0	1.3
Year 2	0.7	0.85
Year 3	0.55	0.625

Note that the ATSC DTV decoder is only 30% more expensive that a DSS decoder in the first year! And CICATS insist that their proposed baseline format decoder is approximately the same price as a DSS decoder.

With some underlying assumptions that are closer to reality even this flawed model (from the consumer electronics viewpoint) begins to show dramatically different results and certainly nothing like the extreme scenario CICATS proferred to influence the Commission's decision making.

Competing manufacturers use very different cost cutting strategies, closely guarding these secrets. Of course the consumer is the ultimate beneficiary of this orderly chaos and will be even more so in the era of DTV, when so much of the internal electronics will be reduced to highly sophisticated but highly miniaturized microcircuits (VLSI).

The unique character of the consumer electronics industry also undercuts the conclusions in the economic analysis by Dr. Selwyn[5] . Clearly Dr. Selwyn is an expert as his 32 listed articles and studies cited reveal -- but in the telecommunications field, not in consumer electronics or television broadcasting, both central to this proceeding.

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[5] Economic Considerations in the Evaluation of Alternative Digital Television Proposals, Exhibit D. CICATS Response.

Therefore, as we explain below, his analysis comparing the costs of a CICATS receiver to an ATSC DTV receiver is based on knowledge, experience and factors having no relationship to the real world of consumer electronics manufacturing. The $91 billion figure he extrapolates from this erroneous methodology is truly outrageous. Broadcasting did not evolve in the U.S. under decades of monopolistic protection as did telecommunications. The consumer buying dynamics, the content delivered, and the consumer electronics manufacturing dynamics are radically different. For years the nature of the marketplace has shaped the unceasing pursuit of manufacturing cost efficiencies on a scale simply unheard of in telecommunications.

Dr. Selwyn opens his analysis with a few basic premises. "...the two most obvious are price and availability of programming..."[6] He specifically states that there will be very limited programming in the early days of DTV. This is a fundamental error. The United States is unique in the world in having vast libraries of high resolution program material. Thirty-five millimeter motion picture film has been the high definition medium of choice in the United States for more than four decades of television programming origination. With a current total annual output in excess of 8000 hours of finished television programming produced on film this is an enormous and immediately available program resource to kick-start any DTV service. The ITU R 601 digital 4:2:2 standard has been the mainstay of most high-end production houses in the U.S over the past decade and a tremendous amount of 4:3 digital SDTV archives exist as a consequence. Virtually all professional television equipment manufacturers

[6] CICATS Exhibit D, p. 3.

have been offering switchable 16:9/4:3 digital 4:2:2 production and post production equipment for the past three years and many broadcasters and program production facilities have recently purchased this equipment. The decade-long developments in HDTV itself have evolved so that all core technologies are now mastered and a new generation of affordable equipment will be readily available to United States broadcasters and producers as soon as a digital broadcasting standard is in place. The manufacturers have already borne the costs of three generations of HDTV development which will be of immense benefit to broadcasters as they begin to purchase equipment for the transition.

The Selwyn analysis also completely ignores what has been happening on a global basis: namely, the titanic scramble for alliances between the giant program providers and media entities propelled by the rapid proliferation of new electronic pipelines to the homes of the world. The sheer speed at which some of these services have been inaugurated in developing countries such as India and China, fueled instantly by huge resources in program material, is clear testament that the marketplace is well-poised to rapidly and effectively service any DTV medium. There is a plethora of programming available and an eager potential audience, undercutting one of the pillars of the Selwyn analysis.

Not surprisingly Selwyn chooses to accept the cost estimates developed by CICATS in arguing his overall economic considerations. After all, he is their paid expert. In their world the cost model conjectures an ATSC DTV converter having an initial cost of $1,350 (almost 3 times the cost of the DSS/CICATS decoder) dropping to

$103 in ten years. But this is a purely theoretical study, and one that does not incorporate any real-world consumer electronics manufacturing scenarios as we explained above where we demonstrated that the ATSC DTV converter is closer to a mere 30% cost premium over that of DSS/CICATS.

However, there is a recent real-world model in the Japanese experience with advanced television. Analyzing this concrete, existing product and its decreasing cost scenario and contrasting it with the mere conjecture of the Selwyn analysis demonstrates yet again the paucity of the CICATS cost argument.

Some would describe the Japanese MUSE-based HiVision system as a failure. As an analog advanced television system, it will certainly be surpassed by ATSC DTV in the future when the Commission mandate promotes ATSC DTV world-wide use. However, there are several important lessons to be learned from the Japanese experience which are particularly pertinent here. As an analog transmission system, the MUSE decoders are incredibly complex and initially required a consortium of five major manufacturers to supply the complete receiver chip set. Yet, within four years the price of these receivers had lowered by a factor of ten and sell today in the neighborhood of $3200 for the same display size as those first receivers. Amazingly, this happened with a single channel of HiVision transmitting very limited programming. According to the strictures of the Japanese government the first three years of the service was considered a test of the transmission, and a mere 150,000 receivers were sold. Yet this extremely limited number was enough to decisively drive down the receiver's cost.

The Selwyn analysis also assumes as a fundamental premise that no integrated digital receivers will be built. That is completely wrong. Decoders and integrated receivers are very much in SEL's plans for DTV. And we can realistically assume that all of our competitors will compete in this market as well.

There is an important indicator of the consumer desires that will support DTV services in the future. The past four years have seen large screen television receivers enjoy growth far outstripping the more conventionally sized displays. Large screen projectors, in particular, have seen sales soar beyond all prior anticipation. Direct view 35-inch CRT displays have become the screen of choice in this receiver category. Clearly, there is a new thirst for large screen viewing experience. This is driven by the vast amount of sports programming readily available at all hours of the day and video (movie) rental made possible by the VCR. This is taking place now despite the limited imaging capabilities of the NTSC system and the less than perfect color-under system of today's VCRs. When consumers see the far higher quality of DTV and digital HDTV on larger screens which present an entirely new sensation of visual reality in the living room, this trend will rapidly escalate -- just the U.S. appetite for movies alone will spur the HDTV growth. Sports will be an added impetus to buy the new receivers as evidenced by the recent surge in HiVision receiver sales coincident with the Japanese HDTV coverage of the Atlanta Olympic Games!

The more products consumers purchase, the more manufacturers will produce and the cost efficiency/lower price cycle seen without exception in the history of consumer electronics products will prevail with DTV as it has in the past. Of course, the first generation of products will be more costly than current NTSC receivers just as all new products are when first introduced. But with the availability of attractive programming and resulting consumer acceptance, costs will rapidly lower. The Selwyn analysis ignores this repeated historical model based on unsupported assumptions and speculations and, therefore, should not be used to impugn the ATSC DTV standard and derail this proceeding.

IV. ANY SUCCESSFUL ADVANCED TELEVISION STANDARD MUST INCLUDE INTERLACE SCAN.

In our initial comments we stated our firm support for the progressive scanning formats central to the ATSC DTV standard and to our equally strong position that the inclusion of interlace formats are an essential part of a successful launch to DTV services (most especially digital HDTV). We made the following points:

- GA encoder supports FULL 1920 x 1080 HDTV progressive scan transmission of 24/30 fps film originated material (the huge source of U.S. programming) from the outset.
- Electronic broadcaster origination of "live" HDTV programs (sports, special events, concerts, news, etc) should also be full HDTV 1920 x 1080 resolution from the beginning of the service.
- Current technological limitations, in both production and transmission, dictate the need for 60 Hz interlace to support the early years of this "live" HDTV service.
- 1920 x 1080 60 frame progressive HDTV production and transmission should remain a central goal for the orderly future evolution of U.S. DTV services.

Our reply comments will address continuing misconceptions and errors that persist in the submissions of others on this complex subject. Professor W. Schreiber is quoted extensively by many, particularly CICATS, on this topic. His views are quite strongly expressed in his own comments. We will first speak to these, as unfortunately they are typical of the misinformation attendant to this topic. The Schreiber comments contain the statements: " ..some still advocate permitting interlace as an "interim" measure because of some supposed advantages, such as cost or resolution, or the lack of a good progressive camera...with the introduction of a high-quality high-sensitivity progressive HDTV camera by Polaroid, there is now no advantage of any kind to any domestic stakeholder, monetary or otherwise, in using anything other than progressive scan from the outset..."[7] The intractable reality is that Professor Schreiber is wrong on all counts.

The Polaroid camera is not a high-sensitivity camera. It is decidedly low-sensitivity as we outlined in our comments. To summarize, for equal signal to noise performance, this lower resolution 1280 x 720 progressive scan camera is 2 f-stops less sensitive than a contemporary 1920 x 1035 60 Hz interlace camera that has been in the global marketplace since 1992.[8] We reiterate that this is not any shortcoming of Polaroid camera technology, merely the practical embodiment of that which is mathematically predictable between interlace and progressive scanned cameras. The advantage of interlace scanning is very real. The lower 1280 x 720 resolution is

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[7] Comments of William F. Schreiber, "Part II: What Kind of a DTV Standard Do We Need?", p.4.
[8] SEL initial comments, pp. 17-18.

absolutely necessary to achieve 60 frame progressive within the same bandwidth as the higher resolution 1920 x 1080 interlace camera.

No broadcaster or program producer will ever commit significant resources to any allegedly high-end professional camera (HDTV or SDTV) that has less sensitivity than a contending camera Major camera purchases today, which can reach millions of dollars, can turn on a fraction of a dB signal to noise advantage. This is the hard reality of the television world and one honed over decades of fierce competition. With the pricing premiums associated with HDTV this competition will only intensify. Sensitivity and signal to noise performance remain the most central performance yardsticks in our industry, as they have been for 60 years. Low light operation is crucial for many sporting and special events as any broadcaster will testify.

Turning to Prof. Schreiber's dismissive comment of "...a supposed advantage in resolution...", we must again redefine the realities of camera imaging. They obey the laws of sampling systems and one does not get something for nothing where television raster scanning is concerned. The published specifications of the Polaroid camera are accurate and open. These specifications are, indeed, impressive given the state-of-the-art of today's imaging technology. Below we compare the resolution specifications of the Polaroid 1280 x 720 progressive scan camera with the published specifications of the 1920 x 1035 interlace camera. These latter specifications have been repeatedly measured and verified by very serious purchasers all over the world.

The Polaroid camera published its horizontal resolution specifications but not the vertical. It is important to first examine the horizontal resolution, however, to correct the inference of Prof. Schreiber that it has high resolution comparable with a 1920 horizontal element interlace camera. Reproduced below are the published specifications of the Polaroid 1280 x 720 camera and those of an existing commercially available 1920 x 1035 interlace camera:

	1280 x 720 Progressive	1920 x 1035 Interlace
Horiz Resolution:		
MTF @ 520 TVL/ph	40%	
Limiting Resolution	700 TVL/ph	
MTF @ 800 TVL/ph		40%
Limiting Resolution		1000 TVL/ph

These numbers speak for themselves. Clearly there is a substantial difference in horizontal resolution.

Now we turn to the more complex issue of vertical resolution. Prof. Schreiber comments that "...in my previous submissions I have disposed of all of these arguments ..."[9] Regrettably he did nothing of the kind, and confusion persists. Now that the Polaroid camera is held up by Schreiber as the proof of his disposal we must re-examine the arguments.

The Polaroid camera has 720 active samples per progressively scanned television frame. They do not publish anything about the design characteristics of their optical prefilter. We will assume it is of a classic design with a zero either at 720 TVL or higher (allowing a small amount of aliasing for the higher vertical MTF). This

[9] Schreiber comments, p.4.

would produce a vertical limiting resolution for the camera capture around 700 TVL at best. If displayed on a high resolution monitor, the display Kell Effect would reduce the visible limiting resolution to 620 TVL at best. However, an appropriate recorder on the output of the camera would still faithfully store the full 700 TVL. (There is no Kell Effect in cameras, either progressive or interlace.) Depending upon the precise characteristic of the optical prefilter the MTF at 520 TVL/ph (the reference quoted by Polaroid for horizontal resolution) in the vertical direction can be expected to be around 30-40% -- a good isotropic balance with the horizontal spec of the camera.

The 1920 x 1080 interlace camera employs a built-in precision FIR Cosine vertical filter (within the CCD readout mechanism) which is the prefilter carefully designed to attenuate the 30 Hz flickering alias, the most notorious of the interlace related artifacts. This has a zero at 1080 TVL. An optical vertical low pass prefilter has a zero at 2160 TVL. The combination of the two produces a Limiting Vertical Resolution of 1000 TVL and an MTF of 25% at 800 TVL. This is the performance at the camera output and what is faithfully recorded on a VTR connected to that output. When connected to an interlaced display the infamous Kell Effect enters the picture (more severely than in the case of the progressive display) and the displayed resolution reduces to about 800 TVL/ph limiting. The bottom line is that an 1920 x 1080 interlace camera has substantially more spatial resolution than a 1280 x 720 progressive scan camera. It is precisely because of this that SEL strongly urges the retention of the interlace option that allows transmission of this higher resolution when live HDTV coverage is involved.

Finally, as to Prof. Schreiber's cost inferences: we believe the $500K price of the Polaroid camera quoted at NAB 1996 is based upon a very small manufacturing quantity. An indication of the probable difference in price can be determined from a new generation 1920 x 1035 60 Hz interlace camera that presently sells for a 40% premium over a typical high-end 525 broadcast studio camera (quantity 10). Further, this HDTV camera also provides a parallel SDTV output!

SEL continues to believe that a cost effective, true 1920 x 1080 high definition 60 frame progressive scan camera equal in sensitivity, resolution, and cost to a current 60 Hz interlace HDTV camera should remain the goal of the U.S. television industry. We know, however, that it will take quite a few years to realize this goal. No amount of nimble paper arguments nor ill-concealed nationalistic references will circumvent this cold technological reality. It is our intention to be one of the leaders in the core technological developments required to make this happen. 1920 x 1080 at 60 frames progressive is the goal of our quest. In the interim, broadcasters and program producers must be able to employ 1920 x 1080 60 Hz interlace for the crucial successful launch of a fully viable HDTV service. The recent coverage of the Atlanta Olympic Games by no less than 25 such interlaced HDTV cameras captured the most stunning high resolution, full motion, high-speed imagery ever seen in the history of television. These were witnessed by many major U.S. broadcasters who visited the venues in Atlanta. As always, the pictures spoke a thousand words. Without the transitional use of interlace, pictures such as these may very well be lost to the avid sports fans of the future. We are confident that the technology will evolve from full high definition interlace to full high definition progressive. SEL sees no barrier whatsoever to this. But the CICATS proposal and the recommendation of Prof. Schreiber would ban even the interim use of interlace and doom any evolution to HDTV.

On the issue of a progressive or interlace transmission, Professor Schreiber attached a new paper from the European RACE/HAMLET project as evidence "...that a progressive transmission with the same number of lines per frame as an interlaced transmission, and therefore with twice the analog bandwidth, can be transmitted at the same data rate as the interlaced transmission when MPEG-2 encoded..." Schreiber next takes a giant leap of faith when he states "... Given this fact, the proposal to use interlace is incomprehensible".[10] We must take strong exception. There is no fact here, only theory. The Grand Alliance learned only too well that theory does not translate well into practice when a reliable transmission encoder must be built and tested.

The RACE/HAMLET paper lays useful groundwork for the large task still ahead of the industry as we march toward achievement of the ultimate goal of transmitting full 1920 x 1080 HDTV at 60 frames per second progressively. Considerable international research is presently underway on the issue of coding both progressive and interlace scanned images. Preliminary results on this work have been repeated by such global leaders as RAI (Italy), AT&T (U.S.), BBC (U.K.), NHK (Japan), and now, the RACE/HAMLET report of Guillotel/Pigeon introduced by

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[10] Schreiber comments, p. 4.

Schreiber. It is important to note that there are strong disagreements among these various researchers. This is normal and healthy in these early days of pioneering work on a complex topic. Most of these reports have been rigorously honest in their descriptions of the many expediencies resorted to in order to create appropriate imagery to support their tests. All had limitations in this respect. For example, the Guillotel/Pigeon paper derived most of their critical video sequences by conversion of original interlaced images to the progressive format used in the tests. Other sequences were captured with a prototype progressive camera (or were synthetically computer generated). Such expediencies are perfectly valid in facilitating early research but are highly questionable when any attempt is made to draw a final conclusion. Academics might feel sufficiently enthused in classifying these conclusions as final. But professional equipment manufacturers must maintain a healthy skepticism as they begin to produce hardware implementations from this fine theoretical research. The recent work of the MPEG committee was a classic example of the painstaking process required to turn research into practical reality. MPEG sent the many participating entities back to the drawing boards many times as a consequence of rigorous testing with difficult video sequences.

Increased noise when using the progressive scanned camera is the crucial issue. It is absent from the Guillotel/Pigeon paper and ignored by Schreiber. In the SEL comments we strongly conveyed the critical effect of picture source noise on coding efficiency. Understandably, this is not an important issue for the computer proponents of progressive scanning as noise is not a part of their normal environment. But it is